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# Geology, Development History, and Exploration Alternatives for Gypsum and Anhydrite Resources in the Wilson Brook–Demoiselle Creek area (Part of NTS 21 H/15), Southeastern New Brunswick

T.C. Webb

ISSN 1205-7150
ISBN 1-55236-774-6
Price: $11.00

March, 2002

Open File 2001-3

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Recommended citation:

WEBB, T.C. 2002. Geology, development history, and exploration alternatives for gypsum and anhydrite resources in the Wilson Brook–Demoiselle Creek area (part of NTS 21 H/15), southeastern New Brunswick. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Open File 2001-4, 33 p.

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March, 2002

New Nouveau
Brunswick

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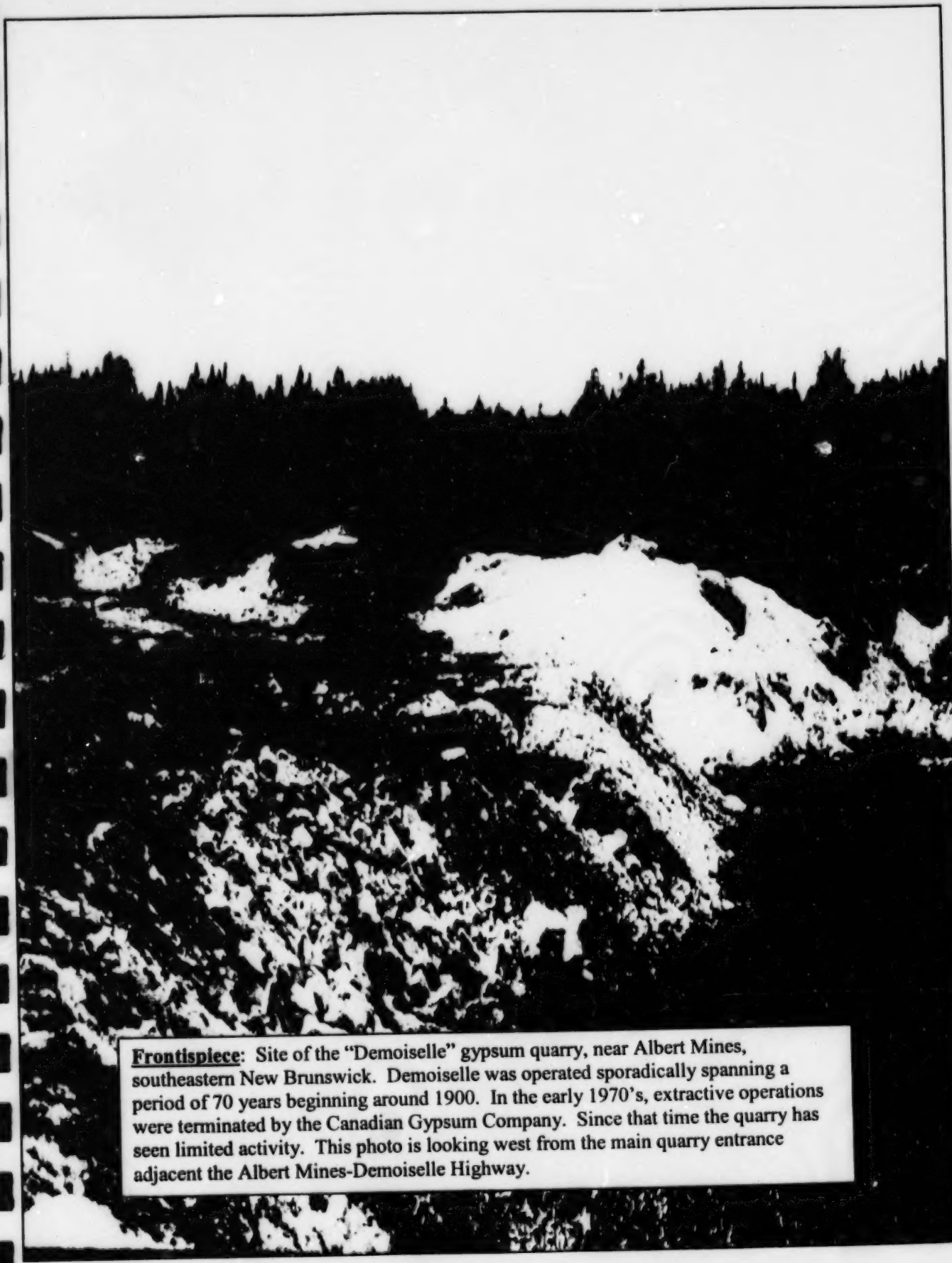


**Frontispiece**: Site of the "Demoiselle" gypsum quarry, near Albert Mines, southeastern New Brunswick. Demoiselle was operated sporadically spanning a period of 70 years beginning around 1900. In the early 1970's, extractive operations were terminated by the Canadian Gypsum Company. Since that time the quarry has seen limited activity. This photo is looking west from the main quarry entrance adjacent the Albert Mines-Demoiselle Highway.

# ABSTRACT

Deposits of calcium sulphate are known to extend over 350 to 400 hectares in the vicinity of Wilson Brook and Demoiselle Creek situated near the small rural community of Albert Mines in southeastern New Brunswick. The Wilson Brook-Demoiselle deposits are represented by a blend of bedded primary anhydrite ($CaSO_4$); secondary, massive gypsum [hydrated anhydrite ($CaSO_4 \cdot 2H_2O$)]; and limited quantities of recrystallized gypsum.

The region's gypsum and anhydrite resources have an exploration and development history that spans almost two centuries.

Recent studies suggest two sulphate-bearing units are preserved in the Wilson Brook-Demoiselle Creek area. Together these units form a sulphate sequence several tens of meters thick. The often problematic, spatial distribution of gypsum with respect to anhydrite in the area may be related to the region's structural development. Thick deposits of high-purity gypsum (>90% $CaSO_4 \cdot 2H_2O$) are considered to be the hydration product of primary anhydrite sometimes accompanied by subsequent episodes of recrystallization that developed adjacent to and at the intersection of water-bearing fault structures.

Considering an exploration model that links the spatial distribution of gypsum deposits to fault zones there remain a few sites west and south of the former Demoiselle quarry that appear as favourable targets for additional high-grade gypsum and associated anhydrite resources.

# RÉSUMÉ

Il est reconnu que les gîtes de sulfate de calcium s'étendent sur plus de 350 à 400 hectares dans les environs du ruisseau Wilson et de la crique Demoiselle près de la petite localité rurale d'Albert Mines, dans le Sud-Est du Nouveau-Brunswick. Les gîtes du ruisseau Wilson et de la crique Demoiselle prennent la forme d'un mélange d'anhydrite ($CaSO_4$) primaire litée, de gypse massif secondaire [anhydrite hydratée ($CaSO_4 \cdot 2H_2O$)] et de quantités limitées de gypse recristallisé.

Les ressources en gypse et en anhydrite de la région ont un passé en fait d'exploration et de mise en valeur qui s'étend sur près de deux siècles.

Des études récentes laissent supposer que deux unités renfermant des sulfates ont été conservées dans le secteur du ruisseau Wilson et de la crique Demoiselle. Ces unités forment ensemble une séquence de sulfates de plusieurs dizaines de mètres d'épaisseur. La répartition spatiale souvent problématique du gypse par rapport à l'anhydrite dans le secteur pourrait être apparentée au développement structural de la région. Les dépôts épais de gypse pur (>90 % $CaSO_4 \cdot 2H_2O$) sont considérés comme le produit de

l'hydratation d'anhydrite primaire quelquefois accompagnée d'épisodes subséquents de recristallisation qui sont survenus dans les secteurs adjacents et aux points de recoupement des structures faillées renfermant de l'eau.

La considération d'un modèle d'exploration reliant la distribution spatiale des gîtes de gypse aux zones faillées dans ce secteur demeure limitée à quelques emplacements, à l'ouest et au sud de l'ancienne carrière Demoiselle, qui semblent être des cibles favorables pour la découverte de ressources supplémentaires de gypse à forte teneur et d'anhydrite associée.

# Geology, Development History, and Exploration Alternatives for Gypsum and Anhydrite Resources in the Wilson Brook-Demoiselle Creek Area, (Part of NTS 21 H/15), Albert County, Southeastern New Brunswick

## Introduction:

***General location:*** The Wilson Brook-Demoiselle Creek calcium sulphate deposits of gypsum and anhydrite combine to extend over a 350 to 400 hectare area, 1 to 2.5 km south and southwest of the rural Albert County community of Albert Mines in southeastern New Brunswick (Figure 1). Albert Mines, is 7.5 to 8 km south of the Village of Hillsborough and almost 40 km south of Moncton, New Brunswick's second largest city.

From Moncton, the coastal two-lane highway, Route #114, connects with a west bound arterial road (the "Albert Mines Road") a few kilometers south of Hillsborough providing one the main access routes to the Albert Mines area.

***General physical setting and access:*** The area underlain by gypsum and related anhydrite deposits is mostly confined to a synclinal or saucer-shaped structural feature referred to as the "Wilson Brook basin" (Figure 1). The structure is closed to the west and opens to maximum width 2 km to the east. It has an east-west axial trace of 2 to 3 km. The basin occupies a valley setting surrounded by steep-sided plateau areas up to 170 m above sea level to the north and east and 240 to 330 m to the south and west.

With the exception of a former quarry site (Figure 1) and a small adjacent tract of open to slightly overgrown field and pasture land, much of the sulphate area is densely forested with a mix of coniferous and deciduous trees.

The area underlain by sulphate is generally free of swamp and marshy areas with Wilson Brook and a few small tributaries providing the major drainage from adjacent areas of higher relief, connecting eventually with Demoiselle Creek to the east (Figure 1).

The Wilson Brook- Demoiselle Creek sulphate resource can be geographically separated into a "north" deposit and an "south" deposit (Figure 1). The northern deposit is estimated to cover slightly over 2 $km^2$, and has been the focus of considerable mining activity near its eastern limits over a twenty-year period beginning in the 1950's. South and adjacent to this northern deposit and structurally separated from it by an east-west trending fault is another related sulphate resource, the "south" deposit, speculated to extend over less than one square kilometers or several decades. It appears that this area may have been the site of one of the first attempts to quarry gypsum in the area well over a century ago.

The sulphate deposits of the region are situated west of the highway connecting

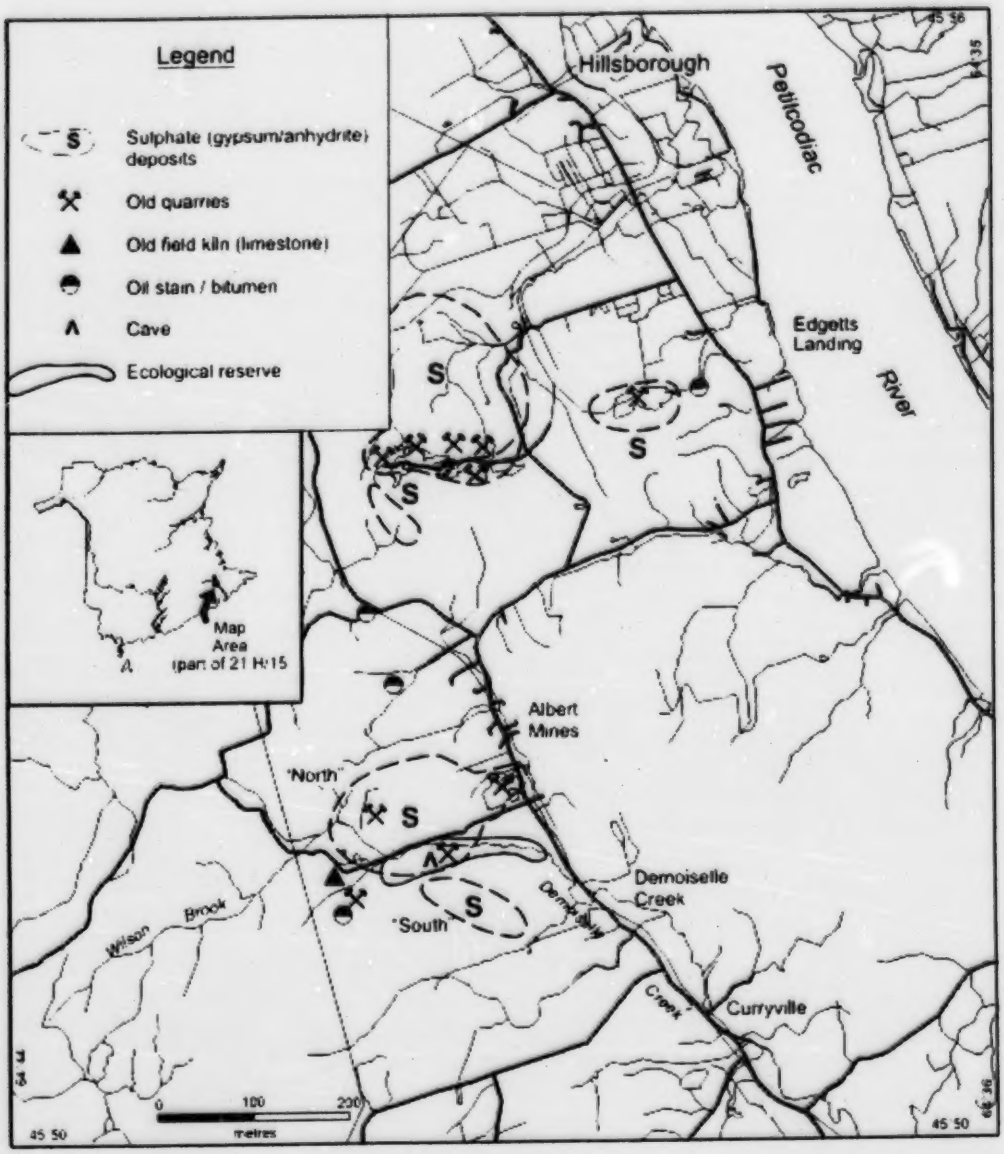



*Figure 1. Location of Wilson Brook-Demoiselle Creek area near Albert Mines, Albert County, southeastern New Brunswick and the general distribution of sulphate deposits.*

Albert Mines and Demoiselle Creek. A narrow gravel road locally referred to as the Underground Lake Road is a few hundred meters south of the entrance to the former Demoiselle gypsum quarry site, near Albert Mines (Figure 1). This road heads west across the southern and central portion of the north deposit and is situated near the northern limit of the south deposit. Other than the former quarried areas and several hiking trails, this road provides one of the few driveable means of accessing the deposit.

The south deposit can be also be easily accessed from the south via a series of abandoned logging roads that connect with the Albert Mines Road less than a kilometer to the east near Demoiselle Creek (Figure 1).

***Local landscape features:*** In general the distribution of sulphate resources in the region is displayed through the development of a "natural" karstic landscape. Karst is an irregular surface topography characterized by closed depressions called sinkholes, caves, cave systems, stream-less valleys, disappearing streams and springs (Figure 2), all developed by the action of surface and underground water on soluble rocks such as gypsum and limestone.

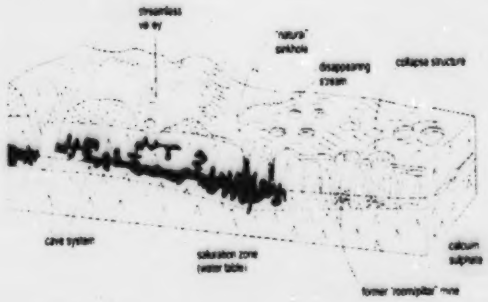


*Figure 2. Underground solution and mechanical erosion of sulphate deposits produces subterranean cave networks and drainage systems, the surface expression of which is referred to as "karst" – a collection of unique surface topographic features characterized by dry and water-filled sinkholes, stream-less valleys, and streams that drain into the subsurface*

One of the most common karst-landscape features throughout the Wilson Brook-Demoiselle Creek area are surface depressions developed where underlying soft gypsiferous bedrock has been dissolved and abraded by waters generally unsaturated with respect to $CaSO_4$. This often results in the formation of a network of subsurface interconnected cavities of various sizes. Eventually the surface expression of these subterranean structures appear as a "sink or sinkhole", a result of structural weaknesses in overlying rock and its subsequent collapse into the cavity below forming closed depression. Surface and related ground water may drain through these sinkholes creating disappearing streams; or if the subterranean plumbing system of the sink becomes clogged, they may fill with water forming small lakes and ponds, sometimes referred to as dolines or dolinas.

Springs will often appear at various locations throughout the area particularly adjacent Wilson Brook where the underground water table intersects the land surface. In a few areas subterranean dissolution has resulted in the local formation of caves or a network of caves that are hydrologically linked (*i.e.* an underground lake) to Wilson

Brook and other drainage networks (Arseneault et.al. 1997)].
In some places dissolution has proceeded to the point where sulphate residuals or "stacks" remain. These structures stand as closely-spaced, steep-sided interconnected columns, several metres in height and diameter. Locally this landscape feature creates a very irregular and hummocky landscape making hiking in the area a rather challenging and formidable undertaking.

***General land use:*** Existing land use in the sulphate area and lands adjacent to it can generally be described as recreational to light industrial (Figure 1).

The area is of interest to outdoor enthusiasts and limited numbers of adventuresome tourists. Locally, unique landscape features and unusual vegetation have resulted in the designation of a 6 to 7 hectare site adjacent Willson Brook as an ecological reserve (E.R. #70). This designated terrain contains an assortment of karst (sinkholes, natural springs etc.), featuring a 240 $m^2$ underground lake and related cave system reported to serve as a winter hibernation site for bats. Also of interest are 40 to 50 m high, white cliffs (Figure 3) extending a few hundred meters along the south side of Wilson Brook. In a few places these cliffs are reported to support a collection of arctic plants. An old field lime kiln and limestone quarry are found near the southwest limit of the sulphate terrain. The kiln provides a very good example of how the early farming community utilized limestone resources as a source of mortar and as a soil amending agent.

Industrial activity in the area is generally restricted to light agricultural and the occasional timber-harvesting operation.

*Figure 3. A spectacular view of the Wilson Brook-Demoiselle Creek sulphate deposits is displayed in the white cliffs adjacent Wilson Brook, near Albert Mines, Albert County, southeastern New Brunswick.*

A maple sugar bush is operated seasonally in part of the sulphate area. The extraction and shipment of small quantities of gypsum from the former Canadian Gypsum Company quarry near Demoiselle also takes place from time to time.

## General Geology:

Among the earliest and most complete descriptions of the gypsum and anhydrite in Wilson Brook-Demoiselle Creek area is one that dates back to late 1800's when Bailey (1898) reported on the resource during his examination of

Table 1. Table of formations: Summary of stratigraphic nomenclature for Hillsborough and adjacent map areas.

**Summary of stratigraphic nomenclature for the Hillsborough and adjacent area**

| Wright (1922) | | Bell, (1927) & Norman (1932) | | Norman, (1941) & Gussow, (1953) | | Van de Poll, (1972) | | McLeod, (1980) | | McCutcheon, (1981) | | St. Peter, (1997) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Series | Zone | Series | Formation | Group & Formation | | Group & Formation | | Group & Formation | | Group & Formation | | Group & Formation | |
| Petitcodiac | 2-3 | | Petitcodiac | Boss Point Fm. | | Boss Point Fm. | | Boss Point Fm. | | Boss Point Fm. | | Cumberland Gp. | Boss Point Fm. |
| | 1 | | Demoiselle | Hopewell Gp. (Enrage Fm.) | | Hopewell Gp. | Enrage Fm. | | | | | | |
| | | | | | | | Shepody Fm. | Hopewell Gp. | Enrage Fm. | Hopewell Gp. | Enrage Fm. | Mabou Gp. | Hopewell Cape Fm |
| | | | | | | | Maringouin Fm. | | | | Hopewell Gp. (undivided) | | |
| | | Windsor | Hillsborough Fm. | Windsor Gp. (subzones A& B) | Unit 10 | Windsor Gp. (Subbzones A & B) | | | Unit 7a | Windsor Gp. | Demoiselle Creek Beds | Windsor Gp. | Lime-Kiln Brook Fm. |
| | | | | | Unit 9 | | | | | | Upperton Fm. | | Upperton Fm. |
| | | | | | Unit 8 | | | | | | Gays River Fm | Macumber Fm. | Gays River Fm. | Macumber Fm. |
| | | | | Hillsborough Fm. | | Moncton Fm. | Hillsborough Member | Hillsborough Fm. | | Moncton Gp. | Hillsborough Fm. | | Hillsborough Fm. |
| | 1 | | | Weldon Fm. | | | Weldon Member | Round Hill Fm. | Rhyolite | | Weldon Fm. | Horton Gp. | Weldon Fm. |
| Weldon | 1-3 | Horton | Weldon Fm. | Albert Fm. | | Albert Fm. | | | Albert Fm. | | Albert Fm. | | Albert Fm. |
| Boyd | 1-3 | | Boyd Fm. | | | | | | | | | | |
| Albert | 1-3 | | Gautreau Fm. | | | | | | | | | | Memramcook Fm. |
| | | | Albert Fm. | | | | | | | | | | |

the gypsum industry at Hillsborough, several kilometers to the north. From a technical perspective, Bailey's and most other early accounts tended to focus more on the industrial development aspects of the gypsum resource in the region, providing only limited background on its geological characteristics.

Among the first attempts to incorporate these deposits into a regional stratigraphic and structural synthesis was that undertaken by Wright (1922). Over several succeeding decades his initial conclusions would later be modified by several workers including: Norman (1932 and 1941), Gussow (1953), Hamilton and Barnett (1970), Van De Poll (1973), McLeod, (1980) and more recently by St. Peter (1989) and St. Peter and Johnson (1997). A summary tracing the development of stratigraphic nomenclature for this and adjacent map-areas is given in Table 1.

The Wilson Brook-Demoiselle Creek map area is underlain by Lower to Upper Carboniferous age clastic sedimentary rocks and related evaporites (Appendix B) that rest on a mixed basement assemblage of mafic to felsic volcanics, metasedimentary and intrusive rocks to the west and southwest. The oldest Carboniferous rocks are those belonging to the Horton Group, represented by red, fine- to coarse-grained alluvial to lacustrine clastics including mudstone, sandstone and conglomerate in association with kerogenous shale, limestone, anhydrite, rock salt and glauberite (Table 1). These rocks are best exposed in the northeast part of the map area where they are found in fault contact with younger Carboniferous strata.

Throughout the region Horton rocks are unconformably succeeded by fine- to coarse-grained alluvial clastics and marine evaporites of the Windsor Group. Windsor rocks, found in the south-central part of the map area, consist of a basal conglomerate succeeded by a sequence of limestone; a mudstone-siltstone-marlstone-breccia; sulphate (anhydrite and gypsum); and locally, a sulphate-limestone breccia, massive sulphate and fine- to coarse-grained clastics. Red, fine- to coarse-grained clastics of the Mabou Group overlie the Windsor strata. These rocks are unconformably succeeded by rocks of the Cumberland Group, a sequence of medium- to coarse-grained arenitic sandstone, pebbly sandstone and quartzose conglomerate.

A series of north-south and east-west trending faults are among the main structural features found in the region. These play a key role in the regional distribution of sulphate and related mineral deposits.

## Detailed Geology:

A detailed geology of the Wilson Brook-Demoiselle Creek map area is presented on Map Plate 2001-1 in Appendix B of this report.

The anhydrite and gypsum deposits in the area are largely confined to a seven $km^2$ structural feature referred to as the "Wilson Brook basin" (Hamilton and Barnett 1970) , situated less than a kilometer southwest of Albert Mines. The central axis of this structure trends northeast-southwest and plunges to the east. It is fault bound to the north, south

and east. Too the west it onlaps Precarboniferous basement rocks.

The basin contains a thick sequence of Windsor Group continental clastic sedimentary rocks and marine evaporites. Coarse-grained clastics of the Hillsborough Formation form the base of the Windsor strata in the area. Typically, represented by red-brown conglomerate, coarse-grained sandstone with minor mudstone, Hillsborough strata can be found exposed in up-faulted terrain along the northern and western boundary of the basin where it onlaps a mixed assemblage of basement rocks.

Hillsborough clastics are conformable with overlying limestone of the Macumber and Gays River formations. Macumber strata, visible in several outcrops scattered around the perimeter of the basin varies in color from reddish grey to olive grey to black. The limestone is typically a thinly laminated wackestone and packstone comprised of intraclastic carbonate of algal origin and other allochtonous material (*i.e.* pellets and oolites ) commonly associated with deep basinal depositional setting. Terms such as algal-laminated and flaggy are frequently used to describe these rocks (McLeod 1980) that range between 6 and 45 m thick (Wright 1922; Hamilton and Barnett 1970).

Macumber rocks interfinger up-dip with platform strata of the Gays River limestone. These rocks, exposed near the southwest boundary of the basin, consist of grey to dark grey algal boundstone and bafflestone (*i.e.* algal mounds) with minor intercalated packstone, wackestone, calcareous mudstone and siliciclastic limestone. They are generally massive and are several meters thick.

Windsor limestones are overlain by a poorly-indurated, red, calcareous mudstone (marlstone) with minor fragments of limestone, shale and sandstone. These rocks are not very well exposed throughout most of the map area, therefore their extent and thickness are not known with confidence. Estimates from regional mapping (Wright 1922; McLeod 1980) suggest the distribution and thickness of this clastic-dominated strata may be quite variable, with estimates ranging from 4 to 60 m. The nature of its contact with overlying sulphate deposits of the Upperton Formation is not known. Hamilton and Barnett (1970) have proposed the contact is conformable and gradational, however drill hole data from the southeastern part of the basin near Demoiselle Creek, reveal red mudstone and limestone breccia interfingering and in direct contact with sulphate. This would suggest a more complicated spatial relationship, possibly involving erosion (physical and chemical) at the sulphate-limestone interface and subsequent deposition of argillaceous and calcareous strata (*i.e . a dis*conformity).

Massive sulphate deposits, consisting of gypsum and anhydrite overlie the limestone and clastic strata. The sulphate strata, commonly referred to as the Upperton Formation comprise a sequence over 80 m thick.

The distribution of gypsum and anhydrite within the Wilson Brook basin is quite variable. Anhydrite is generally dark blue grey to light grey in color. It is typically bedded with minor nodular

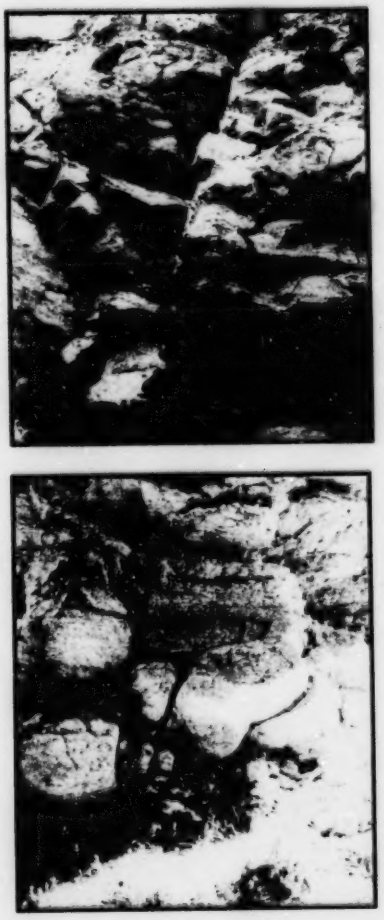


Figure 4. *Anhydrite cannon-ball structures comprised of anhydrite cores surrounded by a exfoliated gypsum crust (see Figure 6, for explanation).*

zones a few meters thick. Nodules sometimes referred to as cannon-ball structures range from a few centimeters to a few meters in diameter (Figure 4 and Figure 6). These frequently occur in a gypsum matrix and are interpreted as (1) marking the outer limits of a hydration front, where anhydrite has been incompletely converted to gypsum and (2) in close proximity to a structural feature (*i.e.* a fault or related zone of fracturing).

The gypsum resource of the Upperton Formation in the basin is generally white to light grey in color. It is typically massive. At places secondary gypsum in the form of selenitic veins and as random tabular and radiating crystal porphyroblasts are distributed randomly throughout very white, massive, recrystallized gypsum (Figure 5).

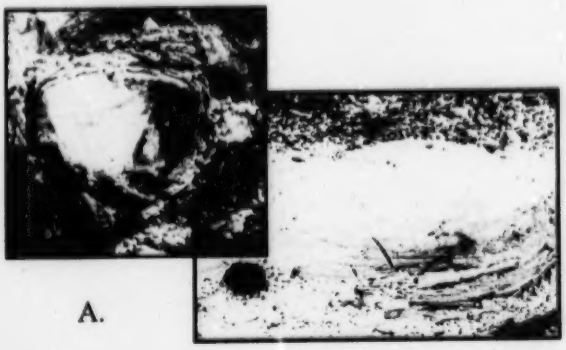
*Figure 5. Gypsum rosettes, consisting of inter-grown thin bladed selenite crystals, radiating outward from a central core. Crystal aggregates are set in a matrix of massive alabastine gypsum.*

The thickness of the Upperton sulphates in the area is estimated at 40 (Hamilton and Barnett 1970) to 150 m (Wright 1922). Recent drilling in the northern part of the sulphate deposit has intersected gypsum in one hole up to 23 m thick (Whaley 1994). Massive anhydrite up to 55 m apparent thickness has been intersected along the northwestern perimeter of the deposit (Whaley 1998).

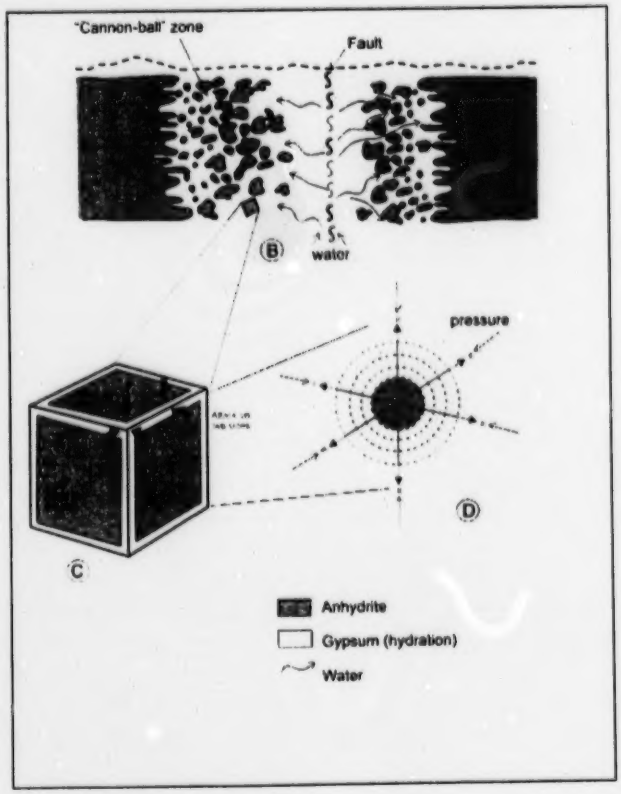
The Upperton sulphates are overlain by a sulphate-clastic breccia sequence. Except along the southern wall of the

Figure 6. *The formation of spherical structures referred to as anhydrite-gypsum cannon-balls results from the subsurface chemical weathering (hydration) of anhydrite. Concentric shells of hydrated gypsiferous rock are successively loosened and separated from a block of anhydrite by water penetrating bounding joints or fracture systems and attacking the block from all sides. These structures indicate proximity to significant fault zones and the outer limit of hydration fronts in the Wilson Brook-Demoiselle Creek area.*

*The formation of anhydrite/gypsum cannon-ball structures (A) is analogous to a form of exfoliation. This process involving the formation and separation of successive concentric layers of hydrated (gypsiferous) material around an anhydrite core frequently occurs in rock cut by intersecting joints and fracture systems adjacent fault structures. Joints and fractures provide avenues where the slow movement of water can attack separate fractured- or joint-bound blocks of anhydrite from all sides (B). The moisture that penetrates between fragmented masses of anhydrite remains long enough for hydration and the subsequent formation of gypsum. As the depth of hydration is greater at corners and edges than along flat surfaces (C), a spherical-shaped shell of gypsum is formed (D). Hydration is accompanied by an increased rock volume. This sets up forces within the rock that cause gypsiferous layers to separate from the main anhydrite mass. A fresh hydration surface is established and the gypsification (anhydrite hydration) process is repeated again and again until an equilibrium in pressure is established between the inner hydrating anhydrite core and the perimeter of the cannon-ball structure. Each successive wrapping surrounding the anhydrite becomes more spheroidal than its outer neighbor, until the original anhydrite block is transformed into an onion-like struicture of concentric shells of residual gypsiferous material (D).*



A.



Demoisellle gypsum quarry, these rocks are not exposed in the map area. However it is intersected by two drill holes at Demoiselle Creek. In this area several sulphate units, represented by massive anhydrite, are in abrupt contact with red clastics containing mudstone, siltstone and limestone clasts set in a calcareous matrix. The stratigraphic significance of this sequence is not known with certainty and only generalizations can be made in regard to its distribution. It may have resulted from the dissolution of intervening units of rock salt and the subsequent collapse of an overlying, regressive sulphate-clastic sequence in the area. These rocks appear to be equivalent in part, to the Lime kiln Brook Formation described by St. Peter and Johnson (1997) several kilometers to the south at Chemical Creek.

The Windsor rocks are unconformably overlain by the Mabou Group represented by red to maroon, fine- to coarse-grained clastics of the Hopewell Cape Formation to the east. Buff to grey, fine- to coarse-grained sandstone, quartz-pebble sandstone and conglomerate of the Boss Point Formation, the basal unit of the Cumberland Group, overlie Mabou clastics in this area as well.

The Wilson Brook basin is an assymetrical synclinal structure partitioned into several small fault blocks by a network of north-south trending normal faults offset by several northeast trending faults. It is suggested that the structural development (*i.e.* faulting) of the greater Hillsborough-Albert Mines-Demoiselle region has had a very significant impact on the selective formation and subsequent distribution of its gypsum and related anhydrite resources. One prominent northeast fault, the Wilson Brook Fault, divides the basin into two structural blocks with the northernmost block containing basically one main sulphate unit, the Upperton sulphates and the block to the south containing two, the Upperton overlain by sulphates and clastics belonging to the Lime kiln Brook Formation.

## Deposit Type:

Calcium sulphate is typically the product of chemical precipitation from saturated brines resulting from evaporation at the air-water interface in marine basinal and related environmental settings. It is suggested that calcium sulphate in the Wilson Brook-Demoiselle area were originally deposited in the form of the mineral anhydrite in a deep-water, marine basin (Figure 7). Sulphate crystals generated at the air-water interface would gradually have settled on the sea floor forming primary bedded selenitic gypsum in shallow water and thick sequences of laminar anhydrite in deeper waters.

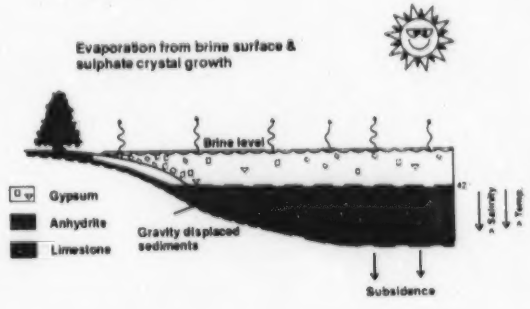



*Figure 7. Typical depositional setting for primary calcium sulphate depsosits.*

Deeper water would have been characterized by elevated salinity and

temperature - a setting where a primary calcium sulphate (*i.e.* gypsum) precipitate would not have been be stable resulting in its alteration to the more stable form, anhydrite.

It appears a considerable portion of the gypsum resource in the region is therefore the product of hydration of primary anhydrite (*i.e.* absorption of water molecules into the anhydrite mineral structure) and are related to the regions structural development. Faults and related fracture systems have had a

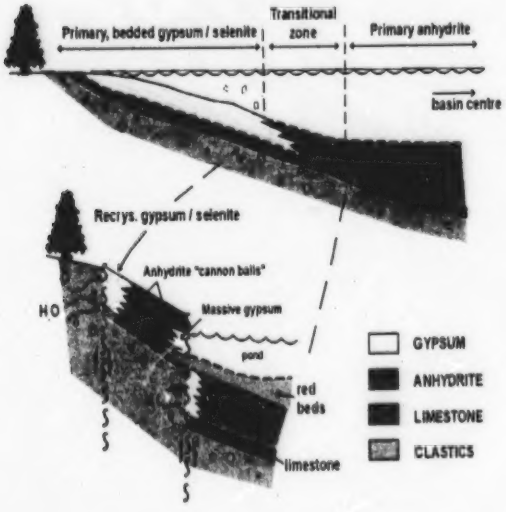



*Figure 8. Formation of gypsum deposits in the Wilson Brook-Demoiselle Creek area is directly linked to active hydration fronts modified along fault zones and related structures and at contacts with underlying and overlying clastics. Anhydrite canon balls generally mark the outer limit of individual hydration zones.*

direct impact on the effectiveness of the hydration process and the complex spatial relationship between gypsum and anhydrite (Figure 8) resulting in narrow linear (veins) massive to recrystallized high grade zones of gypsum gradational into mixed, hetrogeneous zones of anhydrite and gypsum ( *i.e.* anhydrite cannon-ball structures) and massive anhydrite (Figures 4, 6 and 8).

## Exploration and Development History:

At one time the gypsum resources of southeastern New Brunswick served as a cornerstone to the Province's mining industry and a major contributor to its economy. Albert County deposits at Hillsborough and in the Wilson Brook-Demoiselle Creek area, near Albert Mines not only supported an important export trade of crude stone to U.S.-based plaster mills but also were critical to the success of a local plaster manufacturing enterprise for well over a century.

***Gypsum:*** The exploration and development history of gypsum and related resources in the Wilson Brook-Demoiselle Creek area parallels and is directly linked to the established plaster and related manufacturing industry at Hillsborough, a few kilometers to the north (Webb 2001, pp. 14 - 29). Among the earliest comments on the resource is one that dates back to the mid 1800's, where Johnston (1851) in his "Notes on North America", refers to a ... *"Dr. Robb[1], at my request ascended the stream which falls into the bay at Cape Demoiselles* [Demoiselle Creek and Wilson Brook] *for 10 to 12 miles and found cliffs of gypsum eighty to one hundred feet high."*

[1] James Robb (1815-1861) was one of the earliest geologists to work and teach in New Brunswick producing one of the first geology maps of the entire Province.

Johnston's "notes" also refers to some mining activity that was apparently underway in the area ...

*"The owner of one of the farms in which these cliffs occur was said to have sold the right of working, or his interest in the future mines of gypsum on his own lands, for a barrel of flour! One of the purest white deposits of gypsum known in this neighborhood is the property of a Yankee, who exports it to Eastport, in Maine, there burns and crushes it, packs it into casks and transmits it to the more southern states."*

Other early reports indicate gypsum mining at Demoiselle during the early 1890's (Bishop 1925, p. 22). When L.W. Bailey[2] visited the area in 1898, he discovered that parts of the deposit was being worked by the Hillsborough Plaster Company, under the supervision of C.H. Dimock & Co. of Windsor, Nova Scotia (Bailey 1898, p. 99M). Dimock et. al. were apparently operating from a lease area [Leases 1&2 (Barnett 1981] established in 1892 and had recently shipped about 600 tons to New York. Bailey commented that production at the time of his visit was being used in the manufacture of cold water paint and employed five or six men (Bailey 1898). What are believed to be the remnants of this early operation are still visible adjacent the site of an underground lake (Bailey 1898, p. 99M), south of Wilson's Brook (Appendix B). Although not mentioned by Bailey there are accounts of... *"a [another] quarry at Demoiselle Creek developed and operated* [by a Mr. James Blight Jr.] [beginning] *about 1890."* (Bishop 1925, p. 22).

It appears this operation was most probably a forerunner to the former Canadian Gypsum Company quarry (a.k.a. the Demoiselle quarry) now virtually abandoned and worked sporadically near Albert Mines. The specific name of the operation is unclear. However, in Jennison's 1911 report on the Hillsborough and adjacent gypsum resources of the area, mention is made of only one quarry at Demoiselle operating under the name of the Wentworth Gypsum Company (Jennison 1911, p. 95). This enterprise seems to fit the description of the "Blight"-managed operation. Jennison (p.96) wrote that...

*" ...for about 15 years this company* ...[Wentworth Gypsum Company] [had] *...quarried from the surface and shipped annually about 5000 tons. In the later part of 1908 underground operations were initiated and was successful in developing an excellent deposit of snow-white, finely compact variety of gypsum".*

In 1909, production of 7000 tons was railed to Hillsborough over the Harvey/Salisbury Railway where it was shipped to the J.B.King and Company (Wentworth's parent company?) in New York (Jennison 1911, p. 96).

The "Blight" operation at Demoiselle was also alluded to in a 1925 magazine article (Bishop 1925) under the heading of the Hillsborough Plaster Company where it was reported as having been in operation for over twenty years. It was described as an underground mine... *"with the greatest length of tunnel* [reported at]*1000 feet"* ... with an

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[2] Loring Woart Bailey (1839-1925) was one of New Brunswick's most illustrious geoscientists, exploring most of the province and writing hundreds of scientific papers.

annual output of nearly 10 000 tons, employing up to twenty men.

A review of mining records (Barnett 1981) in the Hillsborough-Albert Mines area, suggest that the Wentworth Gypsum Company Limited may have originally operated from leases issued to the Dimock & Co. in the early 1890's. Apparently these were assigned to Wentworth in 1915. Following the amalgamation of the J.B. King Company with the United States Gypsum Company (USGC) in 1924, Wentworth's lease holdings at Demoiselle were eventually transferred to USGC's Canadian affiliate, the Canadian Gypsum Company (CGC), in 1927.

Mining records also show that the Albert Manufacturing Company (AMC) also held a gypsum lease (Lease #6) in the Demoiselle Creek area, north of the Dimock property in 1892. It is unclear if any material was actually extracted at that time although it appears that limited amount of material may have been extracted from area in 1911 or 1912. No notable production is reported from AMC's Demioselle lease holdings until 1919 when about 500 tons were excavated, from a *"newly opened quarry"* and made ready for shipment (Annual Report of the Crown Land Department 1919, p. 66). Only a few thousand tons was reported to have been quarried from the area up until 1922. With the high cost of transporting quarried rock via the Albert Branch of the Canadian National Railway to AMC's Hillsborough mill and its adjacent shipping terminal, 8 miles away, it was obviously much cheaper to quarry gypsum nearer to Hillsborough and make use of the company's private rail system, a direct link from adjacent quarries to the processing facility.

Over the next five years little is known concerning the status of the AMC's Demoiselle operation however, it was evidently lying idle in 1927. In 1930 the lease was subsequently assigned to USGC's Canadian affiliate, the CGC following the purchase of all AMC's holdings in the Hillsborough-Albert Mines area.

Limited information exists concerning the Demoiselle property following its takeover by CGC. In 1950 the company carried out a drilling program to prove reserves and subsequently operated a quarry there up until the early 1970's.

Following the permanent suspension of CGC's Hillsborough operations in 1980 all former gypsum leases in the region were eventually returned to the Province of New Brunswick.

Interest in the Wilson Brook-Demoiselle Creek gypsum property was renewed in 1987 with the staking of 18 mineral claims on behalf of company officials at Eastern Gypsum Inc. With Eastern about to reestablish a wallboard-industry in New Brunswick the company became interested in securing a domestic source of gypsum to feed its manufacturing facility at McAdam in the southwestern part of the province.

Although the Demoiselle area had a long history of gypsum production, historical data on which to properly outline a sufficient reserve base was inadequate. To assist in quantifying and characterizing the remaining gypsum resources in the area, Eastern retained the services of Ken Whaley. Under Mr.

Whaley's direction, a geologic mapping and preliminary sampling program in the vicinity of the former CGC quarry and gypsum/anhydrite exposures along the south side of Wilson Brook was initiated. Several samples from the former quarry site were found to range from 26 to 95 % gypsum while the Wilson Brook area reported mostly anhydrite.

Work on the property continued in 1988 with additional sampling and 245.4 m of diamond drilling distributed among twelve holes. Six holes, roughly 25 m apart were drilled adjacent the southwestern hanging wall of the former CGC quarry (Appendix B). These holes intersected overburden from 9.1 to 23.8 m thick with 1 to 15 meter-intersections of 93.8 to 95.2% gypsum (Whaley 1988). Another group of six holes, were drilled about 800 m west of the quarry wall (Appendix B), intersecting overburden ranging from 1 to 10.4 m thick and a lower quality gypsum (40.6 to 82.5% gypsum) less than 2 m thick. With the 1988-drilling results and other related work in the area Whaley (1988) reported... "[outlining] *some 400 000 tons of massive, high grade gypsum ahead of the southwestern wall of the old Demoiselle quarry*" (Whaley 1988). As a follow-up to earlier work, Whaley (1990) drilled eight more holes (totaling 204 m), west of the old quarry in 1990 (Appendix B). Overburden thickness in the drilled area was found to vary from 10.2 to 19.8 m. One hole intersected 20 m of 94.6% gypsum while 2.1 to 9.0 meters of 86.0 to 96.2 % gypsum was encountered in five other holes. The... "*possibilty of 300 000 tonnes of gypsum ahead of the existing* [quarry] *face*" was reported (Whaley 1990).

In 1990-91 Eastern reopened the former Demoiselle quarry, extracting a bulk gypsum sample to be tested for its suitability as raw material at the company's newly established McAdam wallboard plant. About 20 000 tonnes of 92 to 95% gypsum was extracted, crushed to a 3 inch size and stockpiled at the quarry site. Five thousand tonnes was trucked the 250 km to McAdam for processing.

About a year later (1992) Eastern Gypsum was forced into receivership and its interest in the Demoiselle property came to an end. Two claims covering the old quarry and a remaining stockpile of gypsum were recorded by Ken Whaley of Mactaquac Mining Limited later that same year. A review of past mineral assessment work on the property was undertaken along with a study of potential markets for the remaining quarried material. Almost 12 000 tonnes was eventually shipped to the Brookville Manufacturing Company in Saint John in 1992-93 where it was processed into a soil conditioner and marketed to several potato farming operations in northwestern New Brunswick (Whaley 1994). Another small truckload of hand-picked alabaster (very white, massive stone) was shipped to a Prince Edward Island rock-carving school. In 1994, approximately 300 tonnes went to northern New Brunswick where it was used as seed gypsum during the initial start-up of a flue-gas desulphurization process at NB Power's coal-fired, electric generating station at Belledune.

***Anhydrite:*** Although the Wilson Brook-Demoiselle Creek area is better known for exploration and development activities surrounding its gypsum

deposits extensive anhydrite resources of the area have also attracted attention from time to time.

In the mid 1940's a company called Atlantic Chemicals Company Limited approached provincial government officials with a proposal to manufacture sulphuric acid, superphosphate fertilizer and portland cement utilizing the region's indigenous anhydrite and shale resources.

With the assistance from the Province, several diamond-drill holes aimed at isolating a suitable source of anhydrite were completed in 1946 over a 1.25 - hectare site, south of Wilson Brook (Annual Report 1946; p. 42) (Appendix B). Even though approximately 8 million tonnes of anhydrite were indicated above the level of brook interest in the project was apparently short-lived for some reason (s). No follow-up reporting on the project's progress or associated exploration activity in the area was undertaken.

Interest in the region's anhydrite resource was revived once again in 1998. Titanium Minerals of Canada (TMC) and its subsidiary Anhydrite Minerals Inc. announced intentions to construct a pilot plant to investigate a process involving the blending coal from the Minto area (south-central New Brunswick) and Hillsborough-Demoiselle anhydrite (White 1998, p. 69). The proposed process was to produce high purity sulphur and calcium carbonate for pharmaceutical, agricultural and other related end uses. The TMC announcement captured the interest of officials at Mactaquac Mining Ltd. who already held several gypsum claims in the Hillsborough and Demoiselle areas. With the incentive to reestablish sufficient anhydrite reserves in the region for the proposed process Mactaquac's president, Ken Whaley, recorded 12 claims adjacent to his existing holdings at the former Demoiselle quarry. Five drill holes accounting for approximately 170.3 m were put down in an area west of the quarry. Mr. Whaley reported roughly 5 million tonnes of anhydrite as drill-indicated with potential for an additional several million tonnes in the immediate vicinity (Whaley 1998). Overburden thickness in the drilled area varied from 3 to 5 m with anhydrite (apparent) thickness of 80+ meters.

As of the spring of 2000, little progress had been reported on the proposed anhydrite-coal project as TMC officials continued to secure appropriate investment capital to move the project forward.

Since 1998 gypsum and anhydrite exploration and development activity on the Demoiselle property has been limited however, potential opportunities are still pursued by Mactaquac Mining to establish an appropriate market, extend reserves and expand the development of the remaining gypsum resource at the former quarry and the surrounding area

## Exploration Model:

The structural and geologic evolution of the Wilson Brook basin and adjacent area may be related to development of syn-depositional steep-sided fault scarps around the periphery of a larger subsiding basin (s) (Figure 9).

Deposits of carbonate and sulphate accumulating on the basin margins

would have been fairly prominent physical features of this faulted terrain forming a series of ridges, steep cliffs and /or escarpments.

The termination of evaporite deposition in the Wilson Brook-Demoiselle Creek region is marked by the gradual infilling of these basinal structure(s) by continental clastics of the Mabou Group (Figure 9). This period of sedimentation was characterized by a steady flow of sediment-laden fresh water probably from a positive source area to the south or southeast. This water flowed into the basin area, forming a series of scattered ponds or small lakes juxtaposed anhydrite fault scarps at various locations. These bodies of water would have not only have supplied continuous medium for hydration of the anhydrite to gypsum but also would have exerted considerable pressure against the "anhydrite walls" creating fracture systems further contributing to the penetration of the hydration front within the anhydrite mass. The initial penetration of water into the anhydrite was probably selective advancing along bedding planes and major contacts (*i.e.* limestone-sulphate) as well as upward along secondary expanding fracture systems. The lower-part of this water column would be sediment-laden, reflected in carbonate-sulphate erosion and dissolution and subsequent deposition of a breccia of marlstone and red clastic strata at the interface between the Macumber limestone and the overlying Upperton sulphates. Following this relatively early hydration, later structural adjustments in the form of east-west strike-slip faulting affected the alteration and subsequent distribution of sulphate deposits in the area. The affect would have shattered sulphate beds adjacent faulted areas, making way for additional hydration of anhydrite and the subsequent recrystallization of pre-existing gypsum.

A third fault system is also recognized in the area. These structures trend northwest -southeast and affect the distribution of post-Windsor strata of the Mabou and Cumberland group east of the Wilson Brook basin

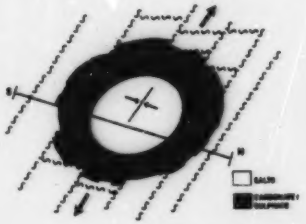
## Preliminary Deposit Evaluation:

Evidence of gypsum mining in the Wilson Brook area dates back to the late 1800's. With a few exceptions most early activity was restricted to small surface quarries and was relatively short-lived. One locality, however, was operated almost continuously over a 30-year period as an underground mine. This operation was eventually adapted to a large surface quarry (the Demoiselle quarry), supplying thousand of tonnes of high quality gypsum to the Canadian Gypsum Company's wallboard manufacturing plant at Hillsborough up until the early part of the 1970's.

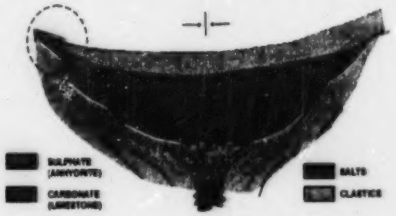
Over the last two decades there have been several attempts to isolate and quantify the gypsum resources remaining in the Wilson Brook - Demoiselle area. Most of this work, involving sampling various gypsum exposures (Appendix A) and follow-up drilling has focused on a 32 hectare area west of the former Demoiselle quarry site. In 1987, 12 holes were drilled in two six-hole north-south trending tiers; one immediately west of the existing quarry face and the other 600 to 800 m further to the west (Appendix B). Holes of the first tier encountered overburden between 9 and 24 m thick. High-grade

Figure 9. As one worker a long time ago so eloquently stated *"the [New Brunswick] gypsum deposits...are exceedingly varied in character, and in their mode of occurrence present many features of geologic interest."* (Bailey 1898). The following is offered as an alternative explanation for what appears to be a rather complex "diagenetic" origin of New Brunswick's gypsum deposits.

During the late Visean, several northeast trending oblique rift-like basins in southern New Brunswick served as important depocentres for thick evaporite deposits

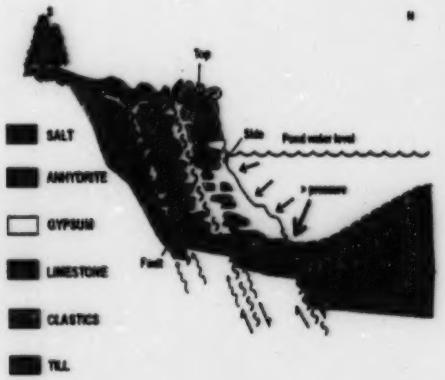


Around the periphery of these basins, syndepositional steep-sided fault scraps developed parallel and also at right angles to the axis of the basin (i.e. collapse structures) responding to more or less continual basinal subsidence. Deposits of carbonate and calcium sulphate accumulating on the basin margins and floor would have been fairly prominent physical features of this faulted terrain, forming a series of ridges, steep cliffs or escarpments. Considering the arid climatic conditions of the late Viséan, surface hydration of any exposed anhydrite (anhydrous calcium sulphate) was probably minimal.




The termination of evaporite deposition in the basin was marked by it's gradual in-filling with continental clastics. This period of sedimentation was characterized by a steady inflow of sediment-laden fresh water. This water would have flowed into the basin probably forming a series of scattered ponds or small lakes juxtaposed the anhydrite fault scarps at various locations. These bodies of water would have not only supplied continuous contact water for anhydrite hydration but also would have exerted considerable pressure against the "anhydrite walls" contributing further to the extent of hydration within the anhydrite body.

Water penetrating the stratified anhydrite was probably selective with hydration advancing along bedding planes and major contacts as well as upward along pre-existing faults and adjacent fracture systems. The location of these ponds and periodic fluctuations in water levels within them may also have influenced the degree of local hydration..




Following this relatively early hydration event(s), various structural adjustments in the area probably resulted in the further alteration of the sulphate deposits. The affect would have been to shatter sulphate beds adjacent to faulted areas, making way for additional hydration of anhydrite and recystallization of existing gypsum (i.e. the formation selenite crystals.

In the late 1950's it was suggested that New Brunswick's gypsum deposits were hydrated from anhydrite during the post Pliestocene time (Sund 1960). However, contrary to this explanation it is suggested that most of the hydration process was probably underway and mostly completed much earlier. In fact some of these deposits have (locally) undergone multiple hydration, recrystallization and possibly even some dehydration throughout their long history.

gypsum (93.8 to 95.2%) was intersected in four. Three these returned 1 to 6 m of gypsum while 15 meters was reported in one. The second drill hole tier reported overburden thickness generally less than 10 m. Gypsum intersections however, did not exceed 2 m and were generally intercalated with massive anhydrite. Gypsum intervals consisted of relatively lower grade material. An overall assessment concluded that drilling was *"...sufficient to outline 200 000 tons of excellent quality gypsum...."* (Whaley 1988 and 1997).

In 1990, eight more holes were drilled 200 to 300 m west of the former quarry face to test the area between the two 1987 drill hole tiers (Appendix B). These holes, drilled over a 2 hectare area, encountered thick overburden ranging from 10.2 to 19.8 m, however, high quality gypsum (generally greater than 94%) was intersected in all but one hole in a thickness ranging from 2 to 9 m. A 20.8-m intersection was reported in one hole. With this information resource estimates referred to the *"possibility ... for 300 000 tonnes* [of gypsum] *ahead of the existing* [quarry] *face assuming no sinkholes or* [former] *underground mine workings"* (Whaley 1990).

In addition to gypsum, extensive anhydrite resources are also characteristic of the sulphate deposits in the Wilson Brook-Demoiselle area. These deposits have also sparked interest over the years. One attempt to quantify anhydrite resource in the area was undertaken by the New Brunswick's Department of Land and Mines in 1946. Several holes drilled over a 16-hectare area south of Wilson Brook confirmed the dominance of massive anhydrite deposits ranging from 17 to 20 m thick in this area.

Renewed efforts to evaluate the nature of anhydrite resources was initiated in 1998 with the drilling of five holes (Appendix B); one in the former Demoiselle quarry and four up to 1200 m west of the quarry site. The hole drilled in the quarry intersected almost 40 m of 99% anhydrite while the two holes near the western edge of the sulphate deposit intersected 18 and 47.6 m of massive anhydrite below an overburden cover of less than 6 meters.

Development and related exploration activity has tended to focus on the northeastern part of the Wilson Brook basin. The potential for additional deposits of high quality gypsum with the exception of that identified through recent drilling remains speculative. It would appear that the spatial distribution of gypsum and anhydrite in the basin is largely controlled structural features (*i.e.* faults). Thick, high quality gypsum tends to form in zones of varying width adjacent faults traces in the area. As distance away form such structure(s) increases a transition from gypsum to mixed anhydrite/gypsum to massive anhydrite is anticipated.

Given this scenario, several areas have been designated with unqualified potential for gypsum and anhydrite. These are displayed on Map Plate 2000-1, (Appendix B). Each area requires more detailed work to confirm the existence, extent and quality of the resource.

***Gypsum:***

**Area G1**: The eastern boundary of this 25 hectare gypsum exploration site is established 300 to 400 m west of the northwest face of the former Demoiselle Quarry. It extends about 800 to 900 m

further to the west and has a maximum width of 300 to 400 m. The area is characterized by several interpreted fault structures considered potential hydration sites for high quality gypsum deposits. To the north a line of what appear to be sinkholes and collapse structures mark the contact between clastics and overlying sulphate. The southern limit is determined by a mixed zone of anhydrite and low-grade gypsum defined by scattered-outcrops and results from a 1987 drilling-program. The eastern part of this proposed exploration area may have been mined previously by underground room and pillar methods, however the extent and details of the operation are unknown. Most of area G1 occupies a wooded hillside that slopes steeply south towards Wilson Brook. Access too much of it is restricted to several old trails connecting eventually with the former quarried area near the Albert Mines-Demoiselle Creek road. The Underground Lake Road provides limited access to the southern part of the proposed exploration area.

**Area G2:** This potential exploration site is located near the western limit of the Wilson Brook basin (Appendix B). Extending over 14 hectares, it is bounded by Wilson Brook to the north and west and the Underground Lake Road to the south. The southwest part is characterized by a line of sinkholes. These karst features mark the contact between sulphates and underlying clastics. The property is generally flat rising only a few meters above Wilson Brook. The Underground Lake Road provides easy access.

Given the spatial distribution of proposed fault structures, the area is favored for gypsum exploration. However, its proximity to Wilson Brook, the increased probability of thick overburden and a high water table would place certain restriction(s) on potential development.

**Area G3:** A 6 hectare area south of the former Demoiselle quarry presents itself as another potential exploration alternative for gypsum. The area appears fault bound on all sides, a favorable structural setting from a gypsum perspective. The Underground Lake Road cuts through the middle of the proposed exploration site and its southern boundary is within a few hundred meters of the Wilson Brook Ecological Reserve (E.R. #70). These factors could become significant issues and should be realistically addressed prior to any exploration proposal for the G3 area.

***Anhydrite:***

**Area A1:** A large, 60 hectare area west and northwest of the gypsum area G1 and 900 to 130 m west of the former Demoiselle quarry is considered to be underlain by an extensive anhydrite resource. Limited drilling near the western limit of the area has intersected massive anhydrite in thicknesses exceeding 47 m (Whaley 1998). The area is characterized by a mixed conifer deciduous forest-cover and is best accessed from the south by a trail that connects with the Underground Lake Road. Many millions of tonnes of anhydrite are speculated for the area.

**Area A2:** Anhydrite is expected to underlie 6 hectares northwest of the area A2 gypsum prospect. Similar to the gypsum G2 site this proposed anhydrite prospect is situated in a area of low relief

south and adjacent to Wilson Brook which could affect its development potential.

**Area A3:** Stratigraphic and structural comparison suggest the presence of sulphate deposits over severla hectares south of the Wilson Brook Fault (Appendix B). A network of old logging roads and walking trails connecting with the Albert Mines-Demoiselle Creek highway to the east and the Underground Lake Raod to the north provide limited access. For the most part a light forest cover, parts of which have been logged several years ago characterize the vegetation cover of the area.

Preliminary field investigations reflect limited bedrock exposure in area A3. The apparent lack of a well-developed karst relief and structural features (i.e. faults) associated with the development of hydration fronts suggests that much of the sulphate resource proposed for the area is probably anhydrite. Clearly more work is required to confirm and assess the true nature of the sulphate resource

## Conclusions:

Sulphate deposits of gypsum and anhydrite are known to extend over 350 to 400 hectares in the vicinity of Wilson Brook and Demoiselle Creek, near the small rural community of Albert Mines in southeastern New Brunswick. The area's gypsum resources have an exploration and development history dating back to the later part of the nineteenth century. Anhydrite resources of the region have also been the subject of sporadic exploration interest since the 1940's.

Over the last century the area has supported gypsum mining on various scales. With the closing of the Canadian Gypsum Company's Demoiselle Quarry, regular mining activity in the area came to an end in the early 1970s. Since that time limited gypsum and anhydrite exploration has been directed primarily within 900 m west of the former quarry site.

Recent studies indicate that two sulphate –bearing units occur in the Wilson Brook-Demoiselle area. The basal unit, the Upperton Formation, consists of a thick sequence of massive, anhydrite and secondary gypsum is overlain disconformably by a heterogeneous brecciated sequence of selenitic gypsum, anhydrite and fine- to coarse-grained clastics referred to as the Lime kiln Brook Formation. The brecciated nature of the Lime Kiln Brook strata suggest it is probably the result of dissolution of more soluble evaporites (*i.e.* salt) and subsequent collapse onto the underlying sulphate strata.

The often problematic, spatial distribution of gypsum with respect to anhydrite in the area is considered linked to the structural development of the region. Thick deposits of high purity gypsum are considered the hydration product of primary anhydrite accompanied by subsequent episodes of recrystallization.

Parts of the Wilson Brook-Demoiselle Creek area maintain reasonable exploration and potential development options for gypsum and/or anhydrite. At this point it is speculated that anhydrite may be more prevalent among the sulphate resources of the area. Remaining resources of massive, high

quality gypsiferous material are more likely limited to a few disconnected, vein-like deposits up to several hundred thousand or more tonnes, found restricted to narrow, sinuous zones adjacent to and at the intersection of local and regional fault structures. It is suggested that within the designated sulphate terrain massive deposits of anhydrite are more typical of an area a few hundred meters adjacent a proposed structural feature (*i.e.* faults and related zones of fracturing). Given this scenario, and apart from the gypsum resources already identified in the immediate vicinity of the former Demoiselle quarry, several areas are speculated to have an unqualified potential for anhydrite and gypsum (Appendix B). With few exceptions each designated area has no or an extremely limited history of exploration activity and therefore will require appropriate measures be taken to confirm the existence and true nature of the resource.

## Acknowledgements:

The writer wishes to acknowledge with gratitude the contributions of Terry Leonard and Ken Mersereau, of the Geological Survey Branch's Mineral Deposits Section. Terry and Ken capably prepared most of the figures and the map plate that accompany this report.

A special thanks to Gwen Martin for providing several historical reference materials that were helpful in reconstructing a chronology of events and issues that have affected the exploration and subsequent development of sulphate deposits in the Wilson Brook-Demoiselle and the nearby gypsum industry at Hillsborough.

Thanks are also extended to Les Fyffe , D.V. Venugopal and Barbara Carroll of the Geological Surveys Branch for their review and constructive comments.

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# APPENDIX A

Compiled chemical analysis of gypsum and anhydrite samples from the Wilson Brook-Demoiselle Creek area, Albert County, southeastern, New Brunswick (1911-1988)

**Appendix A.** Compiled chemical analyses of gypsum and anhydrite samples (outcrop) from the Wilson Brook-Demoiselle Creek area, Albert County, southeastern New Brunswick (1911-1988).

| Source | Wt % | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Insol. | $Fe_2O_3$ | $Al_2O_3$ | $SiO_2$ | CaO | MgO | $SO_3$ | $H_2O$ | NaCl[c] | $CaSO_4 \cdot 2H_2O$ | |
| Jenniso n (1911) | - | 0.18 | | - | 32.04 | trace | 46.30 | 20.40 | - | 97.48 | Sampled from undergrpund quarry of the former "Wentworth Gypsum Company" near the site of the present Demoiselle quarry near Albert Mines. Exact locations unknown. |
| | trace | 0.18 | | - | 36.69 | trace | 49.73 | 12.15 | - | 58.06 | |
| Cole (1930) | 0.27 | 0.08 | 0.01 | - | 33.00 | 0.04 | 46.83 | 19.24 | - | | Sampled from the face of Albert Manufacturing Company quarry at Demoiselle Creek |
| | 0.06 | 0.04 | - | - | 33.00 | 0.04 | 46.98 | 20.00 | - | | Sampled from the mouth of a tunnel on property of the Hillsborough Plaster and Manufacturing Company, Demoiselle Creek |
| Brown and Whaley (1987) | | | | | | | | | | 16 | All samples from the "white cliffs" on west bank of Wilson Brook, 1 to 1.5 km west of intersection of Underground Lake Road and Albert Mines Road. Field tested by water-loss method. |
| | | | | | | | | | | 10 | |
| | | | | | | | | | | 24 | |
| | | | | | | | | | | 51 | |
| | | | | | | | | | | 58 | |
| | | | | | | | | | | | |
| | | | | | | | | | | 94 | Samples from walls of the Demoiselle Quarry (various locations) |
| | | | | | | | | | | 39 | |
| | | | | | | | | | | 55 | |
| | | | | | | | | | | 48 | |
| | | | | | | | | | | 58 | |

**Appendix A (continued).** Chemical analyses of gypsum and anhydrite samples (outcrop) from the Wilson Brook-Demoiselle Creek area, Albert County, southeastern New Brunswick (1911-1988).

| Source | Wt % | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Insol. | $Fe_2O_3$ | $Al_2O_3$ | $SiO_2$ | CaO | MgO | $SO_3$ | $H_2O$ | $NaCl^c$ | $CaSO_4 \cdot 2H_2O$ | |
| Brown and Whaley (1987) (con't) | | | | | | | | | | 53 | Samples from walls of the Demoiselle Quarry (various locations) |
| | | | | | | | | | | 53 | |
| | | | | | | | | | | 95 | |
| | | | | | | | | | | 81 | |
| | | | | | | | | | | 26 | |
| | | | | | | | | | | 88 | |
| | | | | | | | | | | 82 | |
| Whaley (1988) | | | | | | | | | | 95.3 | Sampled from west face , northern "arm" of former Demoiselle Quarry |
| | | | | | | | | | | 85.9 | |
| | | | | | | | | | | 95.5 | |
| | | | | | | | | | | | |
| | | | | | | | | | | 89.8 | Sampled from west face , central part ("tongue area") of former Demoiselle Quarry |
| | | | | | | | | | | 96.8 | Sampled from west face , southern "arm" of former Demoiselle Quarry |
| | | | | | | | | | | 97.2 | |
| | | | | | | | | | | 96.3 | |
| | | | | | | | | | | 71.9 | Sampled from 5 m cliff face, 600 m west of former Demoiselle Quarry and 300 m northeast of "white cliffs" on Wilson Brook |
| | | | | | | | | | | 90.1 | |
| | | | | | | | | | | 65.8 | |
| | | | | | | | | | | 94.8 | |
| | | | | | | | | | | 56.1 | Sampled from exposures 850 m west of former Demoiselle Quarry and 250m north of "white cliffs" on Wilson Brook |
| | | | | | | | | | | 64.8 | |

**Appendix A (continued).** Chemical analyses of gypsum and anhydrite samples (outcrop) from the Wilson Brook-Demoiselle Creek area, Albert County, southeastern New Brunswick (1911-1988).

| Source | Wt % | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Insol. | $Fe_2O_3$ | $Al_2O_3$ | $SiO_2$ | CaO | MgO | $SO_3$ | $H_2O$ | NaCl[c] | $CaSO_4 \cdot 2H_2O$ | |
| Whaley (1988) (con't) | | | | | | | | | | 72.5 | Sampled from exposures 500 m northwest of "white cliffs" on Wilson Brook |
| | | | | | | | | | | 89.1 | |
| | | | | | | | | | | 38.9 | Sampled from exposures 350 m northeast of Wilson Brook and 700 m northwest of "white cliffs" on Wilson Brook |

# APPENDIX B

WEBB, T.C. 2001. Carboniferous geology and gypsum / anhydrite resources of the Wilson Brook-Demoiselle Creek area (part of NTS 21H/15), Albert County, southeastern New Brunswick, New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Map Plate 2001-1.